Remarks

The applicant respectfully requests consideration of the present U.S. Patent application as amended herein. Claims 1, 3-10, 12-16, and 18-21 have been amended. Claims 2, 11, and 17 have been canceled, while claims 22-31 have been added. Thus, claims 1, 3-10, 12-16, 18-31 are pending.

Claim Objections

Claims 3, 4, and 12 were objected to as being dependent upon a rejected base claim. Accordingly, the applicant submits new independent claim 22, which recites the limitations of claim 3, along with new independent claim 30, reciting the limitations of claim 4, and new independent claim 31, reciting the limitations of claim 12. Consideration of new claims 22-31 is respectfully requested.

Claim Rejections – 35 U.S.C. § 102(e)

Claims 1, 10, and 16

Claims 1, 10, and 16 were rejected under 35 U.S.C. § 102(e) as being anticipated by Schmookler (U.S. Patent No. 6,178,435). However, the applicant submits that Schmookler does not anticipate claims 1, 10, and 16 because it does not disclose rounding the input value using a floor technique.

Claim 1 recites:

a first approximation apparatus to approximate a term 2^X, wherein X is a real number, the first approximation apparatus comprising a rounding apparatus to accept an input value, (X), that is a real number represented in floating-point format, and to

compute a first rounded value, $(\lfloor X \rfloor_{integer})$, by rounding the input value, (X), using a floor technique, wherein the rounded value, $(\lfloor X \rfloor_{integer})$, is represented in an integer format;

Claims 10 and 16 similarly recite rounding an input value using a floor technique. Thus, the claimed invention discloses approximating the term 2^X, in part, by rounding the input value, X, using a floor technique such that X is rounded to the nearest integer that is less than X. Schmookler, on the other hand, discloses partitioning the mantissa of X, represented in floating-point format, into integer and fractional parts, xI and xF (Schmookler col. 3, lines 17-20). This is not rounding X using a floor technique. Schmookler goes on to recite that the fractional portion, xF is then 2's complemented if X is negative and the term 2^{xF} is approximated by way of a lookup table (Schmookler col. 3, lines 21-34).

The difference between the two methods of approximating 2^X can be seen clearly by way of example. In order to approximate $2^{-1.3}$, the invention rounds –1.3, using the floor technique, to –2 and effectively calculates 2^{-2} x $2^{.7}$. Schmookler, however, would partition –1.3 into –1 and .3. Since –1.3 is negative, .3 is 2's complemented and becomes -.3. Thus, Schmookler approximates $2^{-1.3}$ by effectively calculating 2^{-1} x $2^{-.3}$.

For at least the reason that Schmookler does not disclose rounding the input value using a floor technique, it does not anticipate claims 1, 10, and 16.

<u>Claims 5, 6, 8, 11, 14, 15, 17, 19, and 20</u>

Claims 5, 6, 8, 11, 14, 15, 17, 19, and 20 were also rejected under 35 U.S.C. § 102(e) as being anticipated by Schmookler. However, these claims depend from and

include the limitations of at least one of the independent claims, 1, 10, and 16, and are not anticipated by Schmookler for at least the reason set forth with respect to the independent claims.

In further regards to claims 6 and 19, the applicants submit that Schmookler does not disclose a term ΔX, as recited by the claims, satisfying the equation $\Delta X = X - \lfloor X \rfloor_{\text{floating-point}}$, where $\lfloor X \rfloor_{\text{floating-point}}$ is the input value, (X), rounded using the floor technique. Schmookler does disclose xF, the fractional part of the mantissa of X, but Schookler's xF is not equal to ΔX when X is a negative value. For example, if X = -1.3, then Schmookler's xF = -.3 which does not equal X, -1.3, minus $\lfloor X \rfloor_{\text{floating-point}}$, -2. Since Schmookler does not disclose a term satisfying the equation $\Delta X = X - \lfloor X \rfloor_{\text{floating-point}}$ for all values of X it does not anticipate claims 6 and 19.

In further regards to claims 8, 15, and 20, the applicants submit that Schmookler does not disclose the recited limitation of obtaining the approximation of 2^X by performing an integer addition operation on the operands $2^{\Delta X}$, represented in floating-point format, and the shifted $\lfloor X \rfloor_{\text{integer}}$ value, represented in integer format. Schmookler merely discloses "combining" the values y_{exp} and yF (col. 3, line 56). Schmookler does not disclose how the combination is to be done, let alone that it is done by the unique method of performing an integer addition operation on a floating-point number. Therefore, Schmookler does not anticipate claims 8, 15, and 20.

Claim Rejections – 35 U.S.C. § 103(a)

Claims 7, 13, and 18 were rejected under 35 U.S.C. § 103(a) as being obvious in view of Schmookler combined with knowledge in the art regarding Taylor Series and Horner's Method. However, the applicant submits that claims 7, 13, and 18 depend from and include the limitations of independent claims 1, 10, and 16, respectively. Since Schmookler does not disclose rounding the input value using a floor technique, as discussed in connection with the § 102 rejections of those claims, no combination of Schmookler with the knowledge of Taylor Series and Horner's Method can teach every element of the claims. Consequently, the examiner has not established a prima facie case for obviousness as required by M.P.E.P. § 2143.

Claims 9 and 21

Claims 9 and 21 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Schmookler in view of Abe (U.S. Patent No. 6, 049, 343). However, the applicant has already argued that Schmookler does not teach the floor technique rounding limitation of the independent claims from which claims 9 and 21 depend. Moreover, Abe is not cited to teach, nor does it teach, such a limitation. As a result, no combination of Schmookler and Abe can teach all of the limitations of the claims and the examiner has not established a prima facie case for obviousness.

Even assuming, merely for the purposes of argument, that the references did teach the floor rounding limitation, they still would not render claims 9 and 21 obvious because the teachings of Abe would not be functional when combined with the teachings of Schmookler without further modifications.

Claim 9 recites

a third approximation apparatus to approximate a term C^Z, wherein C is a constant, positive number and Z is a real number,

the third approximation apparatus using a floating-point multiplication operator to compute a product of $\log_2 C$ x Z, and feeding the product, $\log_2 C$ x Z, into the first approximation apparatus to generate an approximation of C^Z.

Claim 21 similarly recites computing a term C^Z by modifying the general framework used to calculate a term 2^X. Fig. 1 of Abe, however, merely shows a "table of logarithms" similar to the lookup table disclosed in Schmookler. One would presumably approximate C^Z by separating Z into its integer and fractional parts (zI and zF), as taught by Schmookler, and then calculate C^{zF} by substituting Abe's general-purpose table of logarithms for Schmookler's lookup table containing the values of 2^{zF}, where zF is some fractional amount between 0 and 1.

However, anyone who then tried to approximate C^Z in binary floating-point format by combining the mantissa of C^{zF} with zI as the exponent, as taught by Schmookler, would find it to be a very poor approximation indeed. This is true because Schmookler depends on the fact that 2^{xI}, where xI is an integer, when written in binary floating point notation always has a mantissa equal to zero. That is why Schmookler can effectively calculate $2^X = 2^{xI} \times 2^{xF}$ by disregarding the mantissa of 2^{xI}, simply representing 2^X in floating-point format by using xI as the exponent with the mantissa of 2^{xF} as the mantissa of 2^X (Along with the fact that the exponent of 2^{xF} is always zero since xF is limited to values between 0 and 1; it follows that 2^{xF} is less than two and is represented in binary floating-point notation with a non-zero mantissa and an exponent of 0). The same generalization about the mantissa equaling zero is not true of C^{zI}

represented as a binary number, where zI is an integer and C is not equal to two. Therefore, the combination of Schmookler's method of approximating 2^X with Abe's general-purpose table of logarithms would lead to erroneous results.

The applicant submits that since the combination of Abe and Schmookler would not be functional, there is no motivation to combine them and the references do not render claims 9 and 21 obvious.

CONCLUSION

For at least the foregoing reasons, Applicants submit that the rejections have been overcome. Therefore, claims 1, 3-10, 12-16, 18-31 are in condition for allowance and such action is earnestly solicited. The Examiner is respectfully requested to contact the undersigned by telephone if such contact would further the examination of the present application. Please charge any shortages and credit any overcharges to our Deposit Account number 02-2666.

Respectfully submitted,
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